INFORMATION BRIEF ON BIOFUELS (ETHANOL AND BIODIESEL)

PREPARED FOR BACKGROUND ON HB685 BY THOMPSON

PREFACE

The information contained in this brief has been extracted from a number of different sources. Care was taken to use information from credible organizations and publications. Printed copies of many of these sources are available for examination and verification of information. Following a general background section on renewable fuels, information is presented by various characteristics for each of ethanol and biodiesel fuels.

BACKGROUND

Clean, renewable fuels such as ethanol and biodiesel offer substantial benefits for our nation and our state in the areas of energy security, economic development, and environmental quality. Greater energy security is provided by reduced dependence on foreign oil and the diversification of our energy sources. Economic development benefits accrue from research, agricultural production, fuel manufacturing, transportation, and sale of the renewable fuels in addition to reducing the outflow of U.S. dollars to foreign oil producers. Environmental benefits include reduced toxicity of the fuels, cleaner combustion emissions, and reduced emissions of greenhouse gases.

According to the Energy Information Administration imports account for 65 percent of our crude oil supplies, and oil imports are the largest component of the expanding U.S. trade deficit. Renewable fuels can displace the crude oil needed to manufacture gasoline and diesel fuels.

“Some day a President is going to pick up the crop report and they’re going to say we’re growing a lot of corn - or soybeans – and the first thing that’s going to pop in the President’s mind is, we’re less dependent on foreign sources of energy. It makes sense to promote ethanol and biodiesel.” -- President George W. Bush upon signing the Renewable Fuels Standard into law, August 8, 2005.

In August, 2005, President Bush signed into law the Energy Policy Act (EPACT) of 2005, creating a national Renewable Fuel Standard (RFS). This landmark legislation established a baseline for renewable fuel use, beginning with 4 billion gallons per year in 2006 and expanding to 7.5 billion gallons by 2012.

By the time the full renewable fuel mandate of 7.5 billion gallons takes effect in 2012, renewable fuels would represent approximately 2.5% of today’s transportation fuel use.

Many states are considering legislation to capitalize on the rural economic, environmental and energy security benefits of renewable fuels by requiring their use. Minnesota, Hawaii, Montana, Washington, and Missouri have already done so and several other states are considering similar measures.

Biofuels such as ethanol and biodiesel contain molecules that can be used to produce a variety of chemical products in the same way that oil refineries produce multiple products. Thus, the biofuel production facilities may also become biorefineries.

Because of its climate, fertile soils, and agricultural heritage, Louisiana is particularly well suited to develop a biofuels industry and capitalize on the many benefits renewable fuels such as ethanol and biodiesel have to offer.

ETHANOL

General

Ethanol is the common name for ethyl alcohol. Anyone who has made beer or wine has taken the first step toward making ethanol. Microorganisms ferment sugars into ethanol (and carbon dioxide). Wine consists of about 10% ethanol. To produce fuel or industrial ethanol, the low content alcohol goes through a series of distillation phases to eliminate the water. The final product is pure ethyl alcohol. This is what is blended into the gasoline. Ethanol producers have to denature (poison) the product to render it undrinkable and thus not subject to beverage alcohol tax.

Over 30% of all gasoline in the U.S. today is blended with ethanol.

In 2004, there were 26 states that used more than 1 million gallons of ethanol-blended fuel. The national total for 2004 was over 34 billion gallons.

Production

Current capacity for production of ethanol for fuel in the U.S. is about 4.3 billion gallons per year, with about another 2 billion gallons per year capacity under construction.

Approximately 112 million gallons of ethanol was imported to the U.S. in 2005, mostly from Brazil.

The production of ethanol worldwide rose substantially in 2005, totaling more than 12 billion gallons.

In the near future, we will be able to economically extract sugars for ethanol production from cellulosic materials including fast growing trees, grasses, corn stalks, wheat straw, waste paper, seaweed, and many other kinds of plants. Cellulose is also available in vast quantities from wastes (e.g. waste wood, agricultural residue, etc.).

Iogen Corporation in Ottawa, Canada produces just over one million gallons annually of cellulose ethanol from wheat, oat, and barley straw in their demonstration facility.

Ultimately, large scale use of ethanol for fuel will almost certainly require cellulosic technology.

Shipping

Pipelines and petroleum storage tanks contain a certain amount of water, which poses no problem for regular gasoline blends. However, because ethanol is strongly attracted to water, if any gasoline containing ethanol encounters any water in the system the ethanol will separate from the gasoline, leaving a product unsuitable for vehicle performance. For this reason, ethanol blends of gasoline cannot be shipped through pipelines. Further, storage tank owners must take special care to remove all water from their storage tanks before receiving any shipments of ethanol-blended gasoline and to continually monitor these tanks to ensure no water contamination.

There is a perceived inability to ship ethanol through pipelines. According to the Renewable Fuels Association, this is not true. Ethanol can be shipped via pipeline, as it is all over Brazil, but the U.S. pipeline infrastructure is not set up for shipment from ethanol production centers to markets across the country. Thus, the ethanol industry has developed a “virtual pipeline” consisting of rail, truck, and barge options to deliver ethanol to market more effectively than shipping by pipeline.

However, there has been a significant logistical problem recently with ethanol shipments to the Dallas/Ft. Worth area. This was related to the shift from blending MTBE to ethanol for reformulated gasoline supplies for the area.

Co-Product Production

The volume of co-products has increased dramatically with the growth of ethanol production. In 2005, ethanol dry mills produced a record 9 million metric tons of distillers grains. Of this, approximately 75-80% is fed to ruminants (dairy and cattle), 20% to swine, and 3-5% to poultry. While the majority of feed is dried and sold as Distillers Dried Grains with Solubles (DDGS), approximately 20-25% is fed wet locally, reducing energy costs associated with drying as well as transportation costs.

Ethanol wet mills produced approximately 430,000 metric tons of corn gluten meal, 2.4 million metric tons of corn gluten feed and germ meal, and 565 million pounds of corn oil.

Cost

The cost of ethanol has recently increased due to increased demand and limited availability. However, the cost is expected to decline as more ethanol production capacity comes on line and supply logistics are streamlined.

An oil industry analyst recently stated that he expects ethanol demand to increasingly outstrip supply this year and only come back into balance sometime in the latter part of 2007. Farther out, the current rush to invest in ethanol production will continue to bear fruit. “In 2008, ethanol pricing should begin a significant downtrend because of oversupply”. “By mid-2008 or so ethanol spot prices could once again dip under those for front-month NYMEX gasoline”. The same analyst expects that by 2009 ethanol output will more than accommodate demand, adding increasing downward pressure on ethanol prices.

The Volumetric Ethanol Excise Tax Credit (VEETC) created in 2004 streamlines the tax refund system for below the rack blenders to allow a tax refund of 51 cents per gallon on each gallon of ethanol blended with gasoline to be paid within 20 days of blending gasoline with ethanol

A 2005 report by the Consumer Federation of America noted that consumers would save at least 8 cents a gallon by using gasoline blended with 10% ethanol.

Energy Input/Output

One of the arguments raised against ethanol is that more energy is put into ethanol manufacturing than is gained in its use as a fuel. This is based primarily on a study a few years back by Pimentel. In a recent article in the journal Science, it is pointed out that the earlier studies that reported negative net energy incorrectly ignored co-products (e.g. dried distiller grains, corn gluten feed, and corn oil) and used some obsolete data. More recent studies indicate a positive net energy ratio, and all indicate that farmers and ethanol refineries have become more efficient over the years.

In Brazil, the net energy ratio for ethanol production is over 8 to 1. One major reason is that the bagasse, that is the fiber portion of the sugar cane, comes along with the cane to the sugar mill and is used to provide all the energy needed by the mill and the ethanol refinery.

Fuel Properties

Ethanol can be blended in any percentage into gasoline. Most common blends are 5.7% (RFG specification), 10% referred to as gasohol, and 85% referred to as E85.

Ethanol has higher octane (113 octane rating) than gasoline. Small amounts of ethanol are added to gasoline as an octane enhancer. The ethanol in E-10 unleaded gasoline adds two to three points of octane to the gasoline – helping improve engine performance.

Ethanol-blended fuels are approved under the warranties of all auto manufacturers marketing vehicles in the U.S. Some even recommend ethanol use for its clean burning benefits.

However, ethanol has lower energy content per gallon than gasoline and drivers of vehicles using E-10 may experience a reduction in mileage of 2-3%. A substantially larger reduction in mileage is reported for E-85 (around 30% for flex-fuel vehicles manufactured before 2003 and around 15-17% for later models).

Most all major automobile manufacturers around the world currently engineer their vehicles to run on ethanol blends up to 10%. Although there are exceptions, most gasoline powered vehicles built since 1986 can run on E10. However, in older vehicles there may be some material incompatibility and drivability issues.

All mainstream manufacturers of power equipment, motorcycles, snowmobiles and outboard motors permit the use of ethanol blends in their products.

Continued efforts to stretch U.S. gasoline supplies have invigorated interest in E85, a blend of 85% ethanol and 15% gasoline, as well as a greater production of flexible fuel vehicles (FFVs) capable of using this fuel.

Ethanol is less dangerous than gasoline because its low evaporation speed keeps alcohol concentration in the air low and non-explosive.

Economic Development

Economic development benefits accrue from research, agricultural production, fuel manufacturing, transportation, and sale of the renewable fuels in addition to retaining in the state a substantial portion of the dollars that normally flow from conventional gasoline sales (through crude oil costs) to foreign oil producers.

It is estimated that, at the state level, a 50 million gallons per year (MGY) ethanol plant will add $115 million annually to the state economy as measured by Gross State Output (GSP). A 100 MGY plant will increase GSP by $223 million. The increase in gross output (final demand) resulting from ongoing production of a 50 MGY ethanol plant will support the creation of as many as 836 jobs in all sectors of the local economy, while a 100 MGY plant will generate nearly 1,600 new jobs. Ongoing annual operations of a 50 MGY plant will increase household income in the local economy by nearly 30 million annually. A 100 MGY plant will increase household income by more than $50 million.

During recent debate of an ethanol mandate bill in Wisconsin, it was reported that, “For every dollar spent on gasoline, 70 cents leaves the state. But for every dollar spent on ethanol 70 cents stays in the state, building a stronger rural economy, creating jobs, clearing pollution from our air and building energy independence.”

Technical and financial assistance is available for developing ethanol production facilities through the U.S. Department of Agriculture.

Environmental Characteristics

Ethanol is water soluble, non-toxic (except at high concentrations), and biodegradable, thus it poses no significant threat for long-term soil contamination or impairment of groundwater supplies from spills or releases.

It is reported that the use of a 10% ethanol blend fuel reduces tailpipe emissions of particulate matter (PM) by 50%, carbon monoxide emissions by up to 30%, toxics content up to 13% (by mass), and toxics content up to 21% (by potency). Ethanol blends also reduce secondary PM formation by diluting aromatic content in gasoline.

However, it is also reported that ethanol blends at 5.7% (RFG) to 10% can produce a small increase (around 5%) of nitrogen oxides (NOX) in exhaust emissions. This small increase is more than offset by reduction of tailpipe emissions of other pollutants. However, since NOX can react with volatile organic compounds to produce ozone, it is of concern for ozone nonattainment areas such as Baton Rouge where regional ozone modeling has indicated a NOX reduction strategy as being necessary to achieve attainment for the ozone standard.

Argonne National Laboratory recently reported that, “Ethanol-blended fuels reduced CO2-equivalent greenhouse gas (GHG) emissions by approximately 7.8 million tons in 2005, equal to removing the annual GHG emissions of 1.18 million cars from the road”.

A recent article in the journal Science estimates that for average performance today, corn ethanol reduces petroleum use by about 95% on an energetic basis and reduces greenhouse gas (GHG) emissions by about 13%. Ethanol produced from cellulosic material (e.g. switch grass) reduces petroleum inputs for production and reduces GHGs substantially, yielding comparatively greater net energy output and greenhouse gas emissions benefits.

Estimated Costs for Conversion to Ethanol-Blended Fuels at the Retail Level

There will be some costs to retailers of converting from sales of conventional gasoline to gasoline-ethanol blends. Cost items include tank cleaning, water removal, fuel filters and installation. Some indication of the magnitude of these costs was obtained by calls to gasoline retailers in the 5-parish Baton Rouge ozone nonattainment area, who in 2004 had to make the conversions in preparation for a federal reformulated gasoline (RFG) mandate under the Clean Air Act. At that time, a 10% ethanol fuel blend was expected to enter the retail market as the RFG.

Based on the information provided by a number of the larger retailers, conversion costs per site (assuming each site has three tanks) ranged from $1600 to $4200. These costs do not include lost sales due to down time for conversion. In cases where relining of tanks might be required, the additional cost is reported to be about $12,500 per tank.

In those markets converting to ethanol blended gasoline, outages at both the wholesale and retail locations have been reported. However, once a conversion is complete, these markets return to normal operations.

Miscellaneous Interesting Facts

Ethanol has been used in cars since Henry Ford designed his 1908 Model T to operate on alcohol. Trillions of miles have been driven on ethanol-blended fuel since 1980.

The Indy Racing League, home of the Indianapolis 500 announced the switch from methanol to ethanol in 2005, and will use a 10% ethanol blend in 2006. They will fuel their cars with 100% ethanol in 2007.

BIODIESEL

General

Biodiesel fuel can be made from new or used vegetable oils and animal fats, which are nontoxic, biodegradable, renewable resources. Fats and oils are chemically reacted with an alcohol (methanol is the usual choice) to produce chemical compounds known as fatty acid methyl esters. Biodiesel is the name given to these esters when they're intended for use as fuel. Glycerol (used in pharmaceuticals and cosmetics, among other markets) is produced as a co-product.

Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.

Biodiesel is specifically defined as mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats which conform to ASTM D6751 specifications for use in diesel engines. Biodiesel refers to the pure fuel before blending with diesel fuel. Biodiesel blends are denoted as, "BXX" with "XX" representing the percentage of biodiesel contained in the blend (ie: B20 is 20% biodiesel, 80% petroleum diesel).

Since biodiesel can be used in conventional diesel engines, the renewable fuel can directly replace petroleum products; reducing the country's dependence on imported oil.

Production

Biodiesel can be produced by a variety of esterification technologies. The oils and fats are filtered and preprocessed to remove water and contaminants. If free fatty acids are present, they can be removed or transformed into biodiesel using special pretreatment technologies. The pretreated oils and fats are then mixed with an alcohol (usually methanol) and a catalyst (usually sodium hydroxide). The oil molecules (triglycerides) are broken apart and reformed into methylesters and glycerol, which are then separated from each other and purified.

Approximately 55% of the biodiesel industry can use any fat or oil feedstock, including recycled cooking grease. The other half of the industry is limited to vegetable oils, the least expensive of which is soy oil. The soy industry has been the driving force behind biodiesel commercialization because of excess production capacity, product surpluses, and declining prices. Similar issues apply to the recycled grease and animal fats industry, even though these feedstocks are less expensive than soy oils.

Based on the combined resources of both industries, there is enough feedstock to supply 1.9 billion gallons of biodiesel (under policies designed to encourage biodiesel use). This represents roughly 5% of on-road diesel used in the United States.

There are currently 53 plants in the U.S. capable of making 359 million gallons of biodiesel, according to the biodiesel trade association. There are another 44 plants under construction, some of which may include expansions of existing plants. This will add an additional 329 million gallons of annual capacity. This would mean a total of 688 million gallons of biodiesel production capacity could be on line by the end of 2007.

Shipping

Biodiesel can be transported, delivered, and stored using the same equipment as for diesel fuel.

There is a very recent report that suggests that one of the country's major petroleum pipeline companies has quietly conducted at least one test shipment of B5 through one of its pipelines. Allowing shipments of biodiesel through major petroleum pipelines would give the fuel a clear shipping cost advantage over ethanol but also make it immensely more attractive to refiners for use in meeting the federally mandated renewable fuels standard.

Fuel stability with biodiesel can be a concern. However, in many commercial systems, the fuel turn over is in a range (two to four months) where fuel stability with biodiesel has not been problematic. It is generally accepted that B100 and B20 can be stored from 8 to 12 months. The National Biodiesel Board recommends a six month storage life for both. Adding antioxidants and/or stability additives is recommended for storage over longer periods.

Storage of biodiesel in higher level blends is problematic in cold weather as it tends to cloud and congeal at higher temperatures than conventional diesel. However, B20 blends are used in some very cold climates such as northern Minnesota and Wyoming, where temperatures routinely fall below -30 F in the winter. B20 was used in an airport shuttle fleet for four years in Boston with no problems.

Cost

Recent reports (May 15, 2006) show biodiesel rack prices averaging a bit more than $3.17/gal nationwide as compared to just over $2.24 for diesel racks. Biodiesel blends can be expected to be priced proportionately to biodiesel blend levels.

Feedstock costs account for a large percentage of the direct biodiesel production costs, including capital cost and return. It takes about 7.3 pounds of soybean oil, which costs about 20 cents per pound, to produce a gallon of biodiesel. Feedstock costs alone, therefore, are at least $1.50 per gallon of soy biodiesel. Fats and greases cost less and produce less expensive biodiesel, sometimes as low as $1.00 per gallon. The quality of the fuel is equivalent to soy biodiesel fuel.

Energy Input/Output

A 1998 study conducted jointly by the U.S. Department of Energy and the U.S. Department of Agriculture traced many of the various costs involved in the production of biodiesel and found that overall, it yields 3.2 units of fuel product energy for every unit of fossil fuel energy consumed.

Fuel Properties

In addition to being a domestically produced, renewable alternative fuel for diesel engines, biodiesel has positive performance attributes such as increased cetane, high fuel lubricity, and high oxygen content, which may make it a preferred blending stock with future ultra-clean diesel.

The most popular biodiesel blends are B20 (20% biodiesel in petroleum diesel), which can be used for Energy Policy Act of 1992 (EPAct) compliance, and B5 and B2. Any diesel engine can operate on these blends with few or no modifications. When used in low-level blends of B5 or below, biodiesel is transparent to the user. When biodiesel is used as B20, the user may experience a 1-2% decrease in power, torque, and fuel economy; however, these changes are usually not noticeable.

The American Society for Testing and Materials (ASTM) has developed a specification (ASTM D6751-03) for B100 that will be blended with diesel fuel to make low-level biodiesel blends. This specification is intended to ensure the quality of biodiesel used in the U.S., and any biodiesel used for blending should meet this specification.
Biodiesel can be used as an additive in formulations of diesel to increase the lubricity of pure ultra-low sulfur petrodiesel (ULSD) fuel.

Biodiesel offers safety benefits over petroleum diesel because it is much less combustible, with a flash point greater than 150°C, compared to 77°C for petroleum diesel. It is safe to handle, store, and transport.

Economic Development

A study completed in 2001 by the U.S. Department of Agriculture found that an average annual increase of the equivalent of 200 million gallons of soy-based biodiesel demand would boost total crop cash receipts by $5.2 billion cumulatively by 2010, resulting in an average net farm income increase of $300 million per year. The price for a bushel of soybeans would increase by an average of 17 cents annually during the ten-year period.

Estimated Costs for Conversion to Biodiesel at the Retail Level

Biodiesel can be transported, stored, and delivered using the same infrastructure and equipment as for diesel fuel.

Environmental Characteristics

Biodiesel is the first and only alternative fuel to have a complete evaluation of emission results and potential health effects submitted to the U.S. Environmental Protection Agency (EPA) under the Clean Air Act Section 211(b). These programs include the most stringent emissions testing protocols ever required by EPA for certification of fuels or fuel additives. The data gathered complete the most thorough inventory of the environmental and human health effects attributes that current technology will allow.

EPA has surveyed the large body of biodiesel emissions studies and averaged the Health Effects testing results with other major studies. The results are seen in the table below. To view EPA's report titled "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions" visit www.epa.gov/otaq/models/biodsl.htm.

The ozone (smog) forming potential of biodiesel hydrocarbons is less than diesel fuel. The ozone forming potential of the speciated hydrocarbon emissions is 50 percent less than that measured for diesel fuel.

Sulfur emissions are essentially eliminated with pure biodiesel. The exhaust emissions of sulfur oxides and sulfates (major components of acid rain) from biodiesel are essentially eliminated compared to diesel.

Criteria pollutants are reduced with biodiesel use. Tests show the use of biodiesel in diesel engines results in substantial reductions of unburned hydrocarbons, carbon monoxide, and particulate matter. Emissions of nitrogen oxides stay the same or are slightly increased.

Carbon Monoxide -- The exhaust emissions of carbon monoxide (a poisonous gas) from biodiesel are on average 48 percent lower than carbon monoxide emissions from diesel.

Particulate Matter -- Breathing particulate has been shown to be a human health hazard. The exhaust emissions of particulate matter from biodiesel are about 47 percent lower than overall particulate matter emissions from diesel.

Hydrocarbons -- The exhaust emissions of total hydrocarbons (a contributing factor in the localized formation of smog and ozone) are on average 67 percent lower for biodiesel than diesel fuel.

Nitrogen Oxides -- NOx emissions from biodiesel increase or decrease depending on the engine family and testing procedures. NOx emissions (a contributing factor in the localized formation of smog and ozone) from pure (100%) biodiesel increase on average by 10 percent. However, biodiesel's lack of sulfur allows the use of NOx control technologies that cannot be used with conventional diesel. Additionally, some companies have successfully developed additives to reduce Nox emissions in biodiesel blends.

Biodiesel reduces the health risks associated with petroleum diesel. Biodiesel emissions show decreased levels of polycyclic aromatic hydrocarbons (PAH) and nitrated polycyclic aromatic hydrocarbons (nPAH), which have been identified as potential cancer causing compounds. In Health Effects testing, PAH compounds were reduced by 75 to 85 percent, with the exception of benzo(a)anthracene, which was reduced by roughly 50 percent. Targeted nPAH compounds were also reduced dramatically with biodiesel, with 2-nitrofluorene and 1-nitropyrene reduced by 90 percent, and the rest of the nPAH compounds reduced to only trace levels.

Neat biodiesel (100% biodiesel) reduces carbon dioxide emissions by more than 75% over petroleum diesel. Using a blend of 20% biodiesel reduces carbon dioxide emissions by 15%.

Biodiesel contains no hazardous materials and is generally regarded as safe to use. A number of studies have found that biodiesel biodegrades much more rapidly than conventional diesel. Users in environmentally sensitive areas such as wetlands, marine environments and national parks have taken advantage of this property.

Because it is non-toxic and biodegradable, spills or releases of biodiesel (B100) do not represent a significant threat to soil or groundwater contamination.

Miscellaneous Interesting Facts

The concept of using vegetable oil as an engine fuel dates back to 1895 when Rudolf Diesel (1858-1913) developed the first engine to run on peanut oil.

The largest user of B20 is the U.S. Department of Defense, who purchased more than 5 million gallons of biodiesel during the 2003-2004 contracting year. The U.S. Navy has provided guidance for all Navy and Marine stations, saying B20 should be used where adequate fuel tanks are available. Many other federal, state, and alternative fuel provider fleets are also using B20, because it allows them to comply with EPAct regulations. B20 is even sold a retail pumps throughout the country.

The on-road trucking market has been growing in biodiesel use. Much of this is due to Willie Nelson promoting biodiesel as well as forming his own biodiesel company, Willie Nelson Biodiesel, with partners. The company markets B20 “BioWillie” and Nelson is kicking off biodiesel availability at truck stops across the nation.

Many homes, especially in the northeastern U.S. use heating oil for heat. A B5 blend of heating oil known as “Bioheat” is gaining momentum and many distributors are delivering the product to homes.